

Unmanned Common Control Station

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ABSTRACT

Common Control Station for Multiple, Heterogeneous Unmanned Vehicles using STANAG 4586 and JAUS standards are being requested by Military Operators. The goal is to allow a single operator to easily control and maintain situational awareness of many dissimilar unmanned systems. To date the concept has been tested with multiple Unmanned Aerial Vehicles (UAVs), Unmanned Surface Vehicles (USVs), Unmanned Underwater Vehicles (UUVs) and Unmanned Ground Vehicles (UGVs) in simulation and real world exercises. The common control station provides the advantage of decentralized cooperation/coordination for situation awareness of unmanned vehicles and sensors to a distributed force. The reduced logistic costs of one control station and savings for crew training are an added benefit. The goal is to make common control station software with an open and functional architecture that one can easily plug-in new operator interfaces without breaking the essential core capabilities.

INTRODUCTION

While Unmanned Aerial Vehicles (UAVs) have been known around the world since the early twentieth century, technology hindered application to present day situations. Over the past ten years with technology advances in materials and microprocessors, these UAVs have exponential applications important to agriculture, law enforcement, air carriers, military, homeland security, and private use. However, issues associated with Unmanned Control Station design and aircrew training is impacting which unmanned vehicles are used. As the interest in using unmanned vehicles grows both for military and commercial use, so does the interest in controlling multiple unmanned vehicles simultaneously. This includes the desire to operate multiple types of unmanned vehicles (UAVs, USVs, UUVs or UGVs) know as Heterogeneous Unmanned Vehicles. An example of a commercial application would be to use both UAVs and UGVs for broadcasting and security during a NASCAR event. One or more UAVs could give you low cost aerial views of the track and the crowd, while UGVs could collect video on the track's edge and the pit. Other examples would include monitoring and policing boating events using UAVs, USVs and/or UUVs. This use would also cross over to military operations in rivers or littoral waters. The military has a strong desire for operation of unmanned vehicles as a distributed force.

PROBLEM DEFINITION

Today's problem is that the control stations for unmanned vehicles control only a single unmanned vehicle at a time, using proprietary software, datalinks or interfaces. As a result, any operation of multiple types of unmanned vehicles, or vehicles from different vendors, requires multiple control stations. The multiple control stations, or software, can leave the operator with no data fusion and thus poor understanding of how the operation is going. Increased costs are incurred with the need to purchase unique software, datalinks and interfaces from each vendor.

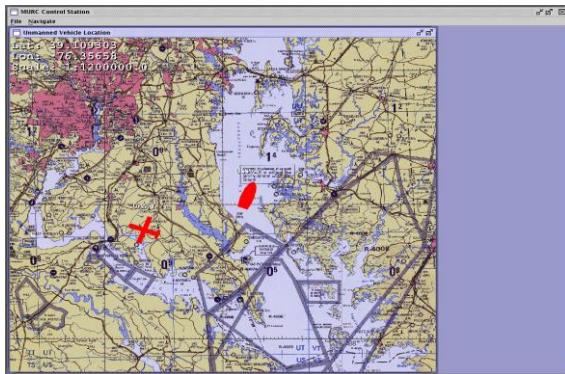
DISCUSSION

A common control station is a critical part of operation involving unmanned vehicles carrying a variety of sensors. To create a common control station, a communications and control station architecture must be in place that allows the control station to interface with all the unmanned vehicles and sensors. This architecture must allow an operator to control multiple vehicles, or payloads of vehicles, as well as allowing other operators to view or accept control of these vehicles or payloads. For communications, a networked environment using industry standards is required. This allows any control station to recognize all control stations, vehicles and payloads on the network. IP is an obvious choice with the large amount of commercial equipment available but other options could be considered.

The key to creating this common control station architecture is not to try and create a single monolithic interface that covers all of the unique aspects of different unmanned systems, which we feel is impossible, but to create a system that provides the user a simple intuitive user interface for control and monitoring the common aspects of unmanned systems with the ability for the system to present to the user the vehicle specific operator interfaces. This concept focuses on the 80/20% rule of life. You can never get to the 100% optimized solution within a realistic time and budget, in fact probably not even with an unrealistic one. What you can do is rapidly get to the 20% solution and then find a unique and usable technique to handle 80% of the problem. The 'common' for controlling unmanned systems is about 20%, but these are the commands and messages that are used 80% of the time. The 'uncommon' that are left normally are only used at discrete mission segments, like startup, and require vehicle specific knowledge and training. This is also the current philosophy for the new NATO UAV controls and monitoring protocol STANAG 4586. All that are not common must be handled by vehicle specific module (VSM), normally created by the vehicle manufacturer. The goal of the common control station is to create a user interface that embraces the 'common' and accommodates the 'uncommon'. To do this, architecture has been designed that allows the uncommon user interfaces to be seamlessly integrated without modifying the core. The result is a common control station that does not need to know anything about a specific vehicle until it comes into contact with it, at which point it will be able to acquire all the necessary controls and information to allow the user to interact with it. Among other things, a control station built under this architecture resists obsolescence and the need to retest (for every vehicle previously controlled) each time a new vehicle is added.

Standards are a beginning to allow a common control station to be effective. To interface with USVs, UUVs or UGVs, the United States Army and Naval Sea System Command is endorsing the use of the JAUS Standard. Currently, DTI and several other companies have demonstrated the control of a USV using the STANAG 4586 Standard.

DTI has demonstrated these concepts with the Open Unmanned Mission Interface (OpenUMI) product. DTI's focus has been carefully directed at the OpenUMI architecture, Vehicle Tool Kit (VTK) and Vehicle Specific Modules (VSM) for easy integration of innovative technologies. The goal of DTI's OpenUMI investment is to make an open and functional architecture into one which can easily plug in new operator interfaces, innovative sensors and unmanned vehicles without breaking essential core capabilities. OpenUMI itself is freely distributed within the United States Government agencies to allow for increased use and acceptance of its novel and proven control interfaces and techniques. The power of OpenUMI is to allow a single operator to easily control and maintain situational awareness of many dissimilar unmanned systems. It has been tested to date with multiple unmanned vehicles in simulation and real world exercises.

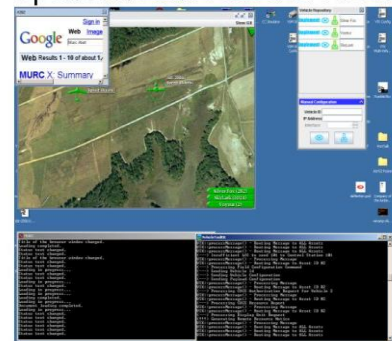


OpenUMI Command Display

As part of the ONR and NAVSEA Sea-based Heterogeneous Operations Uninhabited Teams (SHOUT) demonstration in July of 2004, this architecture was implemented in a very short time period by a diverse set of engineers. This distributed team of engineers from NAVAIR, NAVSEA, SPAWAR, and Industry were able to effectively pull together hardware and software for an operationally relevant demonstration that had several firsts. These firsts included the first time a USV and UAV were simultaneously controlled from a common control station, and the first time a UAV and USV were controlled using the Draft NATO Standard 4586.

Specific OpenUMI capabilities leverage the ability to superimpose real-time information over a moving map tool. This ability can support multiple National Geo-spatial Agency products such as charts and maps. The ability to provide weather overlays notifies users of changes in target area, and provides access to intelligence data. This icon passed system also provides single click access to additional information resources such as available assets, streaming video, still imagery, and mission information such as routes, ingress/egress points, and mission action points. Currently, OpenUMI has been tested to function over a standard wireless network (802.11) with functional tolerance to large variations to available bandwidth and dropouts. The output of the OpenUMI research is the OpenUMI system, which uses an IP-based embedded browser, which is used to access vehicles, payloads or processors over any IP-based network. This would allow any dismounted member of a small assault team or mounted team member to access or control any of the unmanned vehicles or payloads.

OpenUMI Embedded Browser



The common control station interface and hardware must be flexible to the operator needs. OpenUMI demonstrates this using JAVA based code which operates on a wide variety of operating systems and hardware, allowing the same control station to be used with either a human portable, unmanned air, or ground system. OpenUMI has been tested in the Windows and Linux environments. This includes a current Small Business Innovative Research (SBIR) Phase II Contract with NAVAIR to develop a Common UAV Airborne Control Station for P-3 or Multi-Mission Maritime Aircraft (P-8).



In October 2007, DTI was awarded an SBIR Phase II contract to extend the OpenUMI concepts to a Disadvantaged User (DU). A DU is a soldier who needs unmanned vehicle or sensor data but is in a location where they do not have access to a full control station. Current solutions, such as the Rover III do not allow the soldier to be on the move. It allows the soldier to receive data, but not transmit data, and provides limited Situation Awareness. Hence, the current technology is used only on a limited basis prior to a mission.

The DU handheld computer will provide off-the-shelf technology in a package that provides moving map capability with identification of location, IP communications on the move, and display/integration of multiple sensor data by running OpenUMI.

DTI has also been working with the NAVAIR 4.6 Crew Systems department to develop a Control Station that can be operated on high speed boats. DTI successfully completed the initial water testing of the boat seat mounted



Unmanned System Control Station. Shown in the photos is a triple display configuration (Think TacAir) and has the OpenUMI software loaded on the computers along with a few other programs to drive workload. Using the simulator, DTI was able to successfully control a simulated USSV and UAS while underway and used both the joystick and keyboard Operational Interface.



The OpenUMI Payload Operator Interface (POI) is based on connecting to IP-based devices, such as a 3D processor or imaging device. The operator receives an icon on the bottom left screen when data from a device is available. The operator simply clicks on it to view it.



The OpenUMI POI is also capable of bringing in other critical data, such as terrain, maps, GPS data to name just a few.

OpenUMI has demonstrated how a common control station can be expanded to control unmanned vehicles with proprietary systems by developing additional VSMs using a standard VSM Tool Kit (VTK). DTI has controlled or brought in sensor data from currently fielded UAVs, USVs and UUVs. Most of these unmanned vehicles use proprietary interfaces. To develop a VSM the proprietary interface data normally has to be provided by the developers of these vehicles to develop a STANAG 4586 or JAUS VSM. Another option would be for the control station developer or the vehicle developer to develop the VSM themselves using DTI's VTK. The VTK saves many months of work to develop a new VSM and does not require the developer to know the details of the Standards. These VSMs can then be used with any control station that meets the STANAG 4586 and JAUS Standards.

DTI further demonstrated these concepts in a successful "Unmanned Systems Demo" at Wallops Island on November 8, 2007, which involved personnel from ONR, NAVAIR, NAVSEA, Draper Labs, Lockheed Martin, OSD and NASA. The purpose was to determine the degree to which each of the mission planning tools and user interfaces allows a single mission manager to effectively carry out an ISR mission involving an unmanned Family of Systems (FOS). An additional goal was to highlight any system optimization opportunities associated with FOS mission planning and replanning.

Scenario: Intelligence reports that a ship is being loaded with contraband at a foreign port where U.S forces are denied access. Friendly forces will direct a (surrogate) Unmanned Underwater Vehicle (UUV)

to proceed to an area near the port to monitor the departure of the suspected contraband ship. Once the suspect ship departs port, the UUV will report the ship's position and heading. A (surrogate) High Altitude Long Endurance (HALE) aircraft will then be re-tasked via dynamic planning systems and given a new route to attempt a high altitude over-flight at a slant range to get a RADAR signature of the target. Tactical Unmanned Aerial Systems (UAS) will then be launched to help identify and assure that the vessel being tracked is in fact the suspected contraband ship. Upon confirmation, an Unmanned Surface Vehicle (USV) will be directed to an intercept point and will stay on station, tracking the target, until a manned platform is in position.

What was unique about the Unmanned Systems Demonstration was that DTI used OpenUMI and VSMS to pull together a common display while some of the vehicles were controlled by the proprietary control stations of others. This includes the Draper Software which controlled the surrogate UUVs (really a USV) where a VSM was used on the front end with data provided to OpenUMI on the backend. As well as OpenUMI receiving data from the MicroPilot Vision UAV, after all this was an IP Device on the network. DTI also received data from two Kestrel UAVs with Piccolo Autopilots directly controlled by OpenUMI and interfaced with other software decision and planning tools.

The Unmanned Systems Demonstration brought together three UAVs, two USV's (one was a surrogate UUV) and three unmanned software planning tools into an integrated environment that shared data easily. This demonstrated an operation with multiple unmanned vehicles could reduce the number of operator needed, cost of training them, and other logistic costs. It is clearly not cost effective to do multi-vehicle operations with a control station for every vehicle.

DTI is currently expanding OpenUMI by working with multiple companies and government organizations. DTI has demonstrated OpenUMI with the Advanced Ceramics Research (ACR) Silver Fox, NAVAIR's Sonochute Launched (SLUAV) and Wing & Bombay Launched (WBBL) UAV Programs, NAVSEA's USSV Programs, ONR unmanned efforts, and the UUV efforts at OSD and Draper Labs. DTI is currently working with GT Aeronautics, Carolina Unmanned Vehicles, CONTROP, ACR, Lite Machines, Geneva Aerospace, Prioria, SAIC and several others.

CONCLUSION

In conclusion, a common control station can be developed to effectively control multiple heterogeneous unmanned vehicles for operations. This does require the unmanned vehicles to meet common standards such as STANAG 4586 and JAUS.

BIOGRAPHY

Larry Branthoover joined Defense Technologies, Inc. (DTI) in April 2007 as Vice President, Special Operations. DTI is a small R&D company developing Unmanned Vehicle Technology for both the Government and Commercial Sectors. Mr. Branthoover is an Engineer with over twenty-three (23) years of experience (fifteen (15) as a Civil Servant with NAVSEA & NAVAIR) in Unmanned Aerial Vehicles (UAVs), Maritime Aircraft, ASW, Systems Engineering, Information Technology, Management, Interoperability and Fleet Support.

In 2001, Mr. Branthoover joined Naval Air Warfare Center, Aircraft Division 4.6, Human Systems Department where he lead the development of an operator trainer for the Firescout UAV. He has also supported ONR AO FNC UAV efforts and began supporting the MMA program. On the MMA Off-Board Team, he became the MMA UAV Systems Lead starting the Sonochute Launched and Wing & Bombay Launched UAV programs. Mr. Branthoover was then selected to be the Mission Systems Lead for the Broad Area Maritime Surveillance (BAMS) UAV program in 2006.

Mr. Branthoover was born in rural western Pennsylvania in the United States. He attended The Pennsylvania State University where he graduated with B.S. in Electrical Engineering in 1985. He then completed his Masters in Science for Engineering Management from Old Dominion University in 1990.